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IS 11426-1 (2006): Alternating current precision electricity meters for testing purposes, Part 1: Requirements for electro-mechanical meters [ETD 13: Equipment for Electrical Energy Measurement and Load Control]

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भाग 1 विद्युत-यांत्रिक मीटरों की अपेक्षाएँ

(पहला पुनरीक्षण)

Indian Standard

ALTERNATING CURRENT PRECISION ELECTRICITY METERS FOR TESTING PURPOSES

PART 1 REQUIREMENTS FOR ELECTRO-MECHANICAL METERS

(First Revision)

ICS 17.220.20

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NEW DELHI 110002

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Price Group 3

Equipment for Electrical Energy Measurement and Load Control Sectional Committee, ET 13

FOREWORD

This Indian Standard (Part 1) (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Equipment for Electrical Energy Measurement and Load Control Sectional Committee had been approved by the Electrotechnical Division Council.

This standard was first published in 1985. This revision covers the requirements of alternating current precision kilowatt hour meters of the electro-mechanical type. The requirements of such meters of the static type would be covered under Part 2 of the standard, which is under preparation.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

ALTERNATING CURRENT PRECISION ELECTRICITY METERS FOR TESTING PURPOSES

PART 1 REQUIREMENTS FOR ELECTRO-MECHANICAL METERS

(First Revision)

1 SCOPE

1.1 This standard (Part 1) covers the requirements of single phase two-wire and poly phase, 3 phase 3 wire/3 phase 4 wire electro-mechanical meters requiring a degree of accuracy of 0.5. Performance characteristics will be suitable for the purpose of testing electro-mechanical meters with an accuracy of not better than class 2. The meter may be either whole current or transformer operated. It does not apply to poly phase meter in which the principle of measurement requires balanced conditions of load or supply.

1.2 This is applicable to meters constructed to register MWh/kWh and (or alternatively) the number of revolutions of the meter rotor both for fixed and portable meters.

Meters of metering equipments may have single or multi-current and single or multi-voltage ratings.

1.3 Since manufacture of such electro-mechanical meters has almost ceased and with the growing use of more precision static meters [to be covered in IS 11426 Part (2)], the requirements covered under this standard are merely restricted to continued usage of old meters by utilities.

2 EXTERNAL INDUCTORS FOR VOLTAGE CIRCUITS

If provided, external inductors of voltage circuits shall be associated specifically with their particular meters and shall be appropriately marked.

3 ASSOCIATED TRANSFORMERS

When a current and/or voltage transformer is associated with the meter and bears the same associated serial number, the combination shall comply with the requirements for a meter.

4 PHASE SEQUENCE

4.1 Poly phase meters are required to comply with this part of the standard only when they are connected to a system in which the voltages of the phases read their maximum positive instantaneous values in the order shown on the diagram of connections supplied with the meter.

4.1.1 Unless the phase sequence of the mains at the point where the meter is used is known with certainty, it shall be determined by one of the devices available for checking phase sequence, before the meter is connected.

5 CASE/HOUSING

The portable precision meters may be provided with housing of wood or any other suitable material. However it shall have a robust construction.

6 REGISTERS/COUNTERS

The registers, if provided, must consist of minimum four dials provided in the energy registers, and the gearing of the registering mechanism shall be such that at minimum rated current, minimum rated voltage and unity power factor, the pointer of the dials of lowest denomination makes one complete revolution in less than half an hour. It is permissible to apply a multiplying factor to convert the indication of the register to kWh, MWh, the value of the multiplying factor(s), if any, being marked on the meter, or on a label securely attached to some convenient part. The multiplying factor(s) need only be marked for one combination of marked current and marked voltage in a multi-voltage and/or multi-current meter but shall be associated clearly with that particular combination.

The revolution counter shall be of electronic digital display type or pointer type and shall be capable of registering at least 100 revolutions of the rotor. In case of pointer type, the scale of the fastest moving pointer shall be divided into 100 parts, and its diameter and the rotational speed of the pointer shall jointly be so proportioned that at minimum rated current, minimum rated voltage and unity power factor, the tip of the pointer traverses the scale at a speed of not less than 4 cm/s. The rotor may be mechanically coupled to the register/counter but no other auxiliary devices.

7 STANDARD TEST CONDITIONS

7.1 The test conditions are:

a) Meter cover shall be in normal position.

b) For cycloroller type register, right hand side cycloroller shall be moving continuously with the movement of rotor.

c) Voltage circuit must be energized for at least half an hour or the meter attains a steady temperature as the case may be before starting the test.

The measuring current shall be increased/decreased progressively and be energized at the test value for sufficient time to obtain thermal stability for the corresponding speed of revolutions.

d) For poly phase meters:

   1) connection diagram should have phase sequence indication.
   2) voltage and current should be balanced as per Table 1.

7.2 Reference conditions of testing are given in Table 2.

8 LIMITS OF ERROR AND REPEATABILITY OF MEASUREMENTS

8.1 The error of the meter or metering equipment at marked voltage, standard frequency and standard temperature shall not exceed the percentage errors shown in Table 3. Metering equipment having more than one marked current and/or marked voltage shall comply with these requirements for all combinations of marked current and voltage.

8.2 A sequence of repeated measurements is recommended at test points 20 percent I_b and I_{Max}, unity and 0.5 lagging power factors. Not less than five measurements shall be made at each test point. Throughout the measurement the meter shall be in thermal equilibrium, but the controlling devices shall be operated between successive measurements.

The results of the repeated measurements are used to calculate the value '*s*' which is the elimination of the standard deviation, by the formula given below:

$$s = +\sqrt{\frac{1}{n-1}\sum_{i=1}^{n} (E_i - E)^2}$$

where

E_i = error of the meter determined by one individual measurement of a sequence of repeated measurements at a certain test point,

E = mean value of the error E_i, and

n = total number of individual measurements.

The maximum values of s, that is, s_{Max}, are given in Table 3 for the specified test points of the working ranges.

8.3 A meter for testing purpose is required to have stable errors over a narrower load range, compared to revenue meters. In other words, a testing meter in service with a high mean value of error, but a low value for s, may still be used for measurements of high accuracy when correction is applied by calculation or otherwise, on the basis of such mean value of low uncertainty. This is to be borne in mind during continual usage of these electro-mechanical meters and the values of E_{max} may be relaxed to double the values specified in Table 3 for such cases.

9 EFFECT OF INFLUENCE QUANTITIES

9.1 When determining the effect of individual influence quantity, the conditions and the values of all other influence quantities shall be stated under test conditions. The influence quantities taken into consideration for fixing the above reference conditions are as per Table 2.

9.2 Influence of Ambient Temperature

The determination of the mean temperature coefficient for a given temperature shall be made over a temperature range of 20°C, that is, 10°C above and 10°C below that temperature, but in no case shall the temperature be either lower than 0°C or higher than 40°C. The mean temperature coefficient shall in all cases be determined at least for reference temperature and shall not exceed the limits given in Table 4.

9.3 The variation of errors due to other influence quantities shall be as given in Table 5.

9.4 Methods of testing for effects of influence quantities are given in Annex A.

10 NON-REGISTRATION WITH CURRENT ALONE

The rotor of a meter shall not make more than one revolution in 15 min with the voltage circuit(s) open and with marked current flowing in the main circuit(s).

11 NON-REGISTRATION WITH VOLTAGE ALONE

The rotor of a meter shall not make more than one revolution in 15 min with the main circuit(s) open when the voltage circuit alone is energized either when the marked voltage is applied or when it is increased by 10 percent (*see* Annex B).

12 PERCENTAGE ERROR LIMITS AT UNBALANCED LOADS

12.1 For poly phase meters carrying a single phase

Table 1 Voltage and Current Balance

(*Clause* 7.1)

Sl No.	Poly Phase Meter	Class 0.5 Meter
(1)	(2)	(3)
i)	Each of the voltages between line and neutral or between any two lines shall not differ from average corresponding voltage by more than	±0.5 percent
ii)	Each of the currents in the conductors shall not differ from the average current by more than	1.0 percent
iii)	The phase displacements of each of these currents from the corresponding line to neutral voltage; irrespective of the power factor shall not differ from each other by more than	2°

Table 2 Reference Conditions

(*Clause* 7.2)

Sl No.	Influence Quantity	Reference Value	Permissible Tolerance for 0.5 Class Meter
(1)	(2)	(3)	(4)
i)	Ambient temperature	Reference temperature 25°C (*see* Note 1)	± 2°C
ii)	Working position	Vertical working position	± 0.5°
iii)	Voltage	Reference voltage	± 0.5 percent
iv)	Frequency	Reference frequency	± 0.3 percent
v)	Wave form	Sinusoidal voltage and current	Distortion factor less than 2 percent
vi)	Magnetic induction of external origin	Magnetic induction equal to zero (*see* Note 2)	Induction value which causes a variation of error not greater than 0.1 percent

NOTES

1 If the tests are made at a temperature other than the reference temperature, including permissible tolerances, the results shall be corrected by applying the appropriate temperature coefficient of the meter. The temperature characteristics should be supplied with reference meters.

2 The test consists of:

a) *for single phase meter*, determining the errors at first with the meter normally connected to the mains and then after inverting the connections to the current circuits as well as to the voltage circuits. Half of the difference between the two errors is the value of the variation of error. Because of the unknown phase of external field, the test has to be made at 0.1 I_b at unity power factor and 0.2 I_b at 0.5 power factor.

b) *for three phase meter*, making three measurements at 0.1 I_b with unity power factor after each of which the connections to the current circuits and to the voltage circuits are changed over 120°, while the phase sequence is not altered. The greatest difference between each of the errors so determined average value is the value of the variation of error.

Table 3 Percentage Error Limits and Standard Deviation (Single Phase Meters and Poly Phase Meters with Balanced Loads)

(*Clauses* 8.1 *and* 8.3)

Sl No.	Value of Current	Power Factor	Percentage Error Limits E_{Max}	Standard Deviation s_{Max}
(1)	(2)	(3)	(4)	(5)
i)	5 percent I_b	1	±1.0	—
ii)	10 percent I_b	1	±0.5	—
iii)	20 percent I_b-I_{Max}	1	±0.5	0.09
iv)	10 percent I_b	0.5 lagging	±1.2	—
		0.8 leading	±1.2	—
v)	20 percent I_b-I_{Max}	0.5 lagging	±0.8	0.13
		0.8 leading	±0.8	—

Table 4 Temperature Coefficient

(*Clause* 9.2)

Sl No.	Value of Current	Power Factor	Mean Temperature Coefficient Percent/°C
(1)	(2)	(3)	(4)
i)	0.1 I_b-I_b	1	0.03
ii)	0.2 I_b-I_b	0.5 lag	0.05

Table 5 Other Influence Quantities

(*Clause* 9.3)

Sl No.	Change in the Value of Influence Quantities with Respect to Reference Conditions	Value of Current (Balanced Load Unless Stated)	Power Factor	Limits of Variation in Percentage Error
(1)	(2)	(3)	(4)	(5)
i)	Oblique suspension	0.05 I_b	1	1.0 per degree change
		0.5 I_b	1	0.5
ii)	Voltage ± 10 percent	0.2 I_b to I_b, I_b	1,0.5 lag	0.5 ± 0.7
	Frequency ± 5 percent	I_b	1	0.5
		I_b	0.5	1.0
iii)	Magnetic induction of external origin 0.5 mT (*see* Note 1)	I_b	1	1.5
iv)	Wave form 10 percent of third harmonic in the current (*see* Note 2)	I_b	1	0.5
v)	Reverse phase sequence	0.1 I_b to I_b	1	1.5
		0.5 I_b (single phase load)	1	2.0
vi)	Heating of meter current circuit(s) (*see* **A-5**)	I_b	1	0.3
		I_b	0.5	0.5
vii)	Heating of voltage circuit(s) (*see* **A-6**)	I_b	1	0.75
		0.2 I_b	1	0.75

NOTES

1 A magnetic induction of external origin of 0.5 mT produced by a current of the same frequency as that of the voltage applied to the meter and under the most unfavourable conditions of phase and direction shall not cause a variation in the percentage error of the meter exceeding the values shown in the table. This magnetic induction may be obtained by placing the meter in the centre of a circular coil, 1m in mean diameter, of square section and of small radial thickness relative to the diameter, and having 400 ampere turns.

2 The distortion factor of the voltage shall be less than 1 percent. The variation in percentage error shall be measured under the most unfavourable phase displacement of the third harmonic in the current compared with the fundamental current.

load, but with balanced poly phase voltage applied to the voltage circuit, percentage error shall be as given in Table 6.

12.2 The percentage error of the meter shall not exceed 2.5 at marked current (I_b) lagging 60° behind the voltage on that element.

13 EXCESS CURRENT APPLICABLE TO METER ONLY (TYPE TEST)

The meter shall be capable of carrying continuously without any damage to the meter 120 percent of marked current.

NOTE — Measuring equipment excess current — Where a meter is operated from external current transformer(s) not specifically associated with the meter (*see* **3**), the excess current rating of the metering equipment may be governed by the performance of the current transformer(s), but in no case the equipment will carry more than 120 percent of marked current.

14 MARKING

14.1 The meter shall not be marked for use on a range of voltage, for example, 200/250. A single voltage meter shall be marked for a specific voltage and a multi-voltage meter shall be marked for specific voltages.

14.2 Both the voltage and current for single and/or multi-tapping should be marked either on the name plate or on the case. Number or revolutions per unit corresponding to voltage and current combination should be marked.

Table 6 Percentage Error Limit at Unbalanced Loading

(*Clause* 12.1)

Sl No. (1)	Value of Current (2)	Power Factor (3)	Percentage Error Limits (4)
i)	From 0.2 I_b to I_b	1	±1.5
ii)	0.5 I_b	0.5 lagging	±1.5
iii)	I_b	0.5 lagging	±1.5

NOTE — The difference between the percentage error when the meter is carrying a single phase load at basic current and unity power factor and the percentage error when the meter is carrying a balanced load at basic current and unity power factor shall not exceed 1 percent.

ANNEX A

(*Clause* 9.4 and *Table* 5)

METHODS TO BE ADOPTED IN CARRYING OUT TESTS FOR CONFORMITY WITH THE SPECIFICATION

A-1 Except where the provisions of a clause require otherwise, tests for conformity with this specification shall be carried out with all the meter voltage circuits energized at marked voltage, standard frequency, and in the correct phase relationship as indicated on the diagram of connections supplied with the meter. For precautions in use, *see* Annex C.

When making tests, care should taken to see that the percentage error of the meter has become constant at the test current and voltage, particularly when making tests after the meter has been subjected to the application of higher currents. Observations should be extended over a sufficiently large number of revolutions to ensure the determination of mean error.

A-2 CHANGE OF ERROR DUE TO VARIATION OF VOLTAGE

The over-or-under voltage shall be applied for a period long enough (with a minimum of 60 min) to ensure that the meter has reached a reasonably steady temperature. The change in percentage error of meter due to change of voltage is the difference between the percentage error the meter under this condition, after a reasonably steady temperature has been reached, and the percentage error of the meter at marked voltage.

A-3 CHANGE OF ERROR DUE TO VARIATION OF AMBIENT TEMPERATURE

This test requires an enclosure which can be kept at a steady temperature for several hours and which is free from draughts. The meter under test shall be kept at the initial temperature for at least 4 h or until the percentage error is substantially constant for 3 consecutive readings at that temperature; after temperature has been raised or lowered it shall be kept at that temperature or else to the new value until the percentage error of the meter is substantially constant for three consecutive readings.

A-4 CHANGE OF ERROR OF THE ENERGY ELEMENT DUE TO VARIATION OF FREQUENCY

This test may take several hours at each frequency, in order to ensure, when determining the value of the change, that the percentage error of the meter has become constant, both at the standard and altered frequencies.

A-5 CHANGE OF ERROR DUE TO HEATING IN METER CURRENT CIRCUIT(S)

The marked voltage shall be applied (with not more than one quarter of the marked current) for a period of at least 6 h before the test; the test current shall then be applied and an immediate reading (i) of the percentage error of the meter be obtained. The test current shall be maintained until the percentage error (ii) is constant at that current. The change permitted under **9.3** is the difference between (i) and (ii), power factor conditions being as specified in **9.3** (*see* Table 5).

A-6 CHANGE OF ERROR DUE TO HEATING IN VOLTAGE CIRCUIT(S)

Before making observations of percentage error, the test current(s) shall be applied for a period of not less than 2 h with the voltage circuit(s) disconnected. The initial observation of percentage error shall be made immediately when the voltage circuit is energized, at marked voltage and subsequent observations of the percentage error shall be made after a period of 6 h.

ANNEX B

(*Clause* 11)

VOLTAGE CREEP IN METERS USED FOR TESTING

B-1 Some methods of meter testing involve interruptions of the current supply whilst the voltage supply is maintained. When a meter is to be used for testing other meters in this way, sometimes with an associated current transformer and sometimes without, it is important for the user to check that the meter does not register with voltage alone if the secondary or the current transformer concerned is left connected across the meter current terminals, the primary circuit being interrupted.

ANNEX C

(*Clause* A-1)

PRECAUTIONS DURING INSTALLATION

C-1 To ensure maximum accuracy, the meter should be mounted vertically in a situation away from extremes of heat or cold avoiding the proximity of apparatus liable to produce strong magnetic fields. The supporting structure should be free from vibration such as that caused by rotating machines or energized transformers, since this tends to increase the rate of wear of the lower bearing. Where a meter is fitted with mechanical (as distinct from electro-mechanical) means for resetting the pointers to zero reading, care should be taken to avoid exerting undue and sudden force to the mechanism. A slow steady pressure should be applied to the resetting device otherwise it may be damaged and the accuracy of the meter impaired.

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